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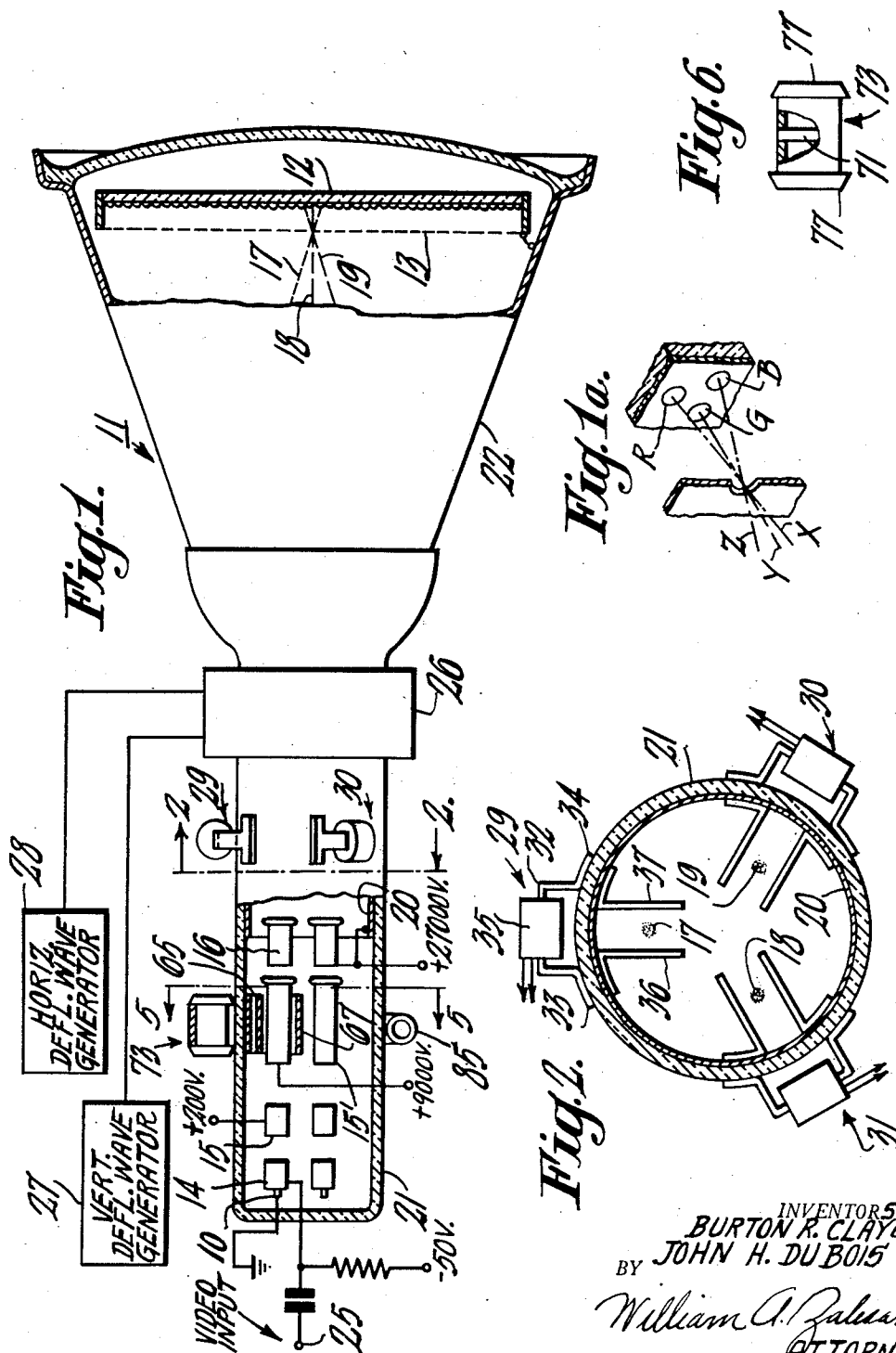
B. R. CLAY ET AL

**2,806,164**

# BEAM CONVERGENCE APPARATUS FOR TRI-COLOR KINESCOPIES

Filed Aug. 2, 1954

3 Sheets-Sheet 1



INVENTORS  
BY **BURTON R. CLAY &  
JOHN H. DUBOIS**

William A. Zaluski  
ATTORNEY

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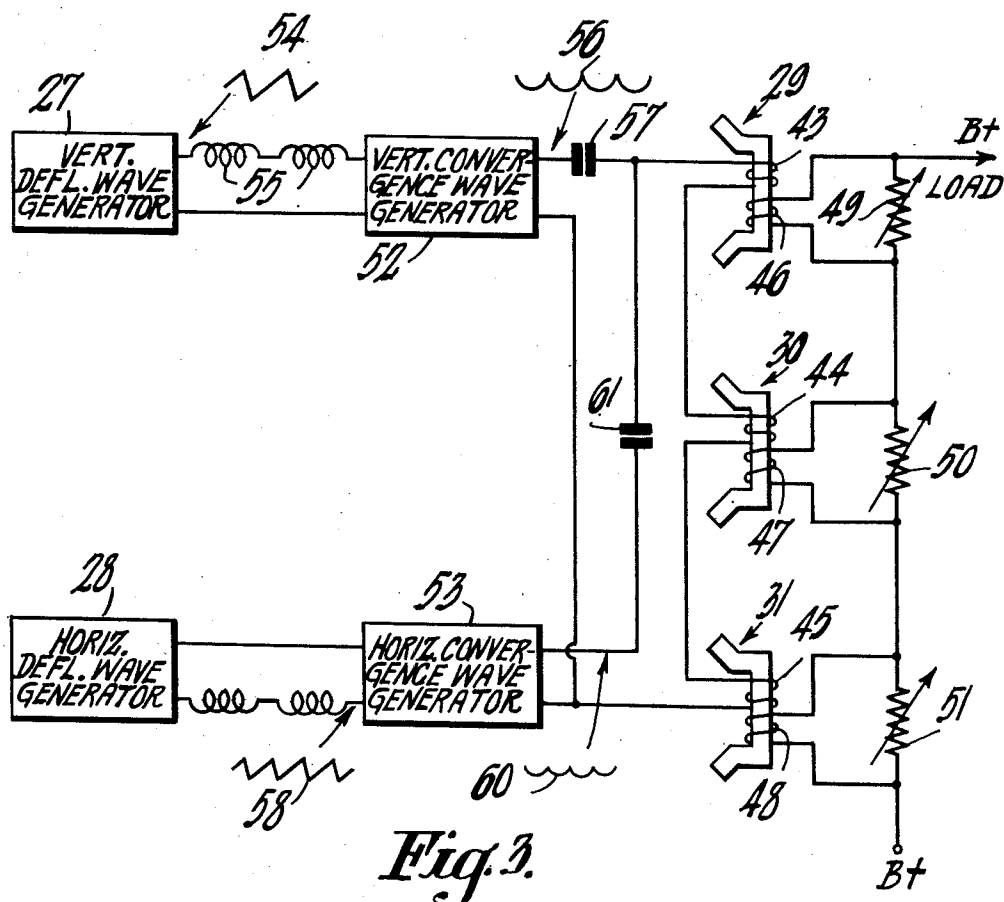
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INVENTORS  
BURTON R. CLAY &  
JOHN H. DUBOIS  
BY  
William A. Zalesak  
ATTORNEY

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3 Sheets-Sheet 3

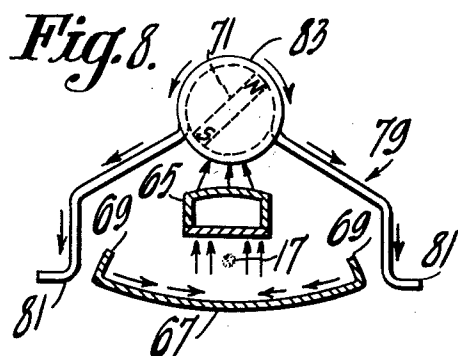
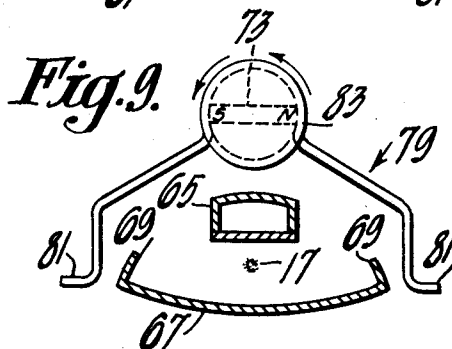
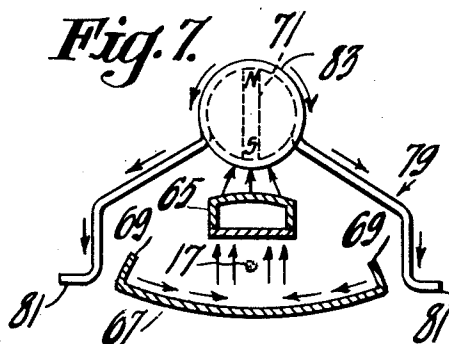
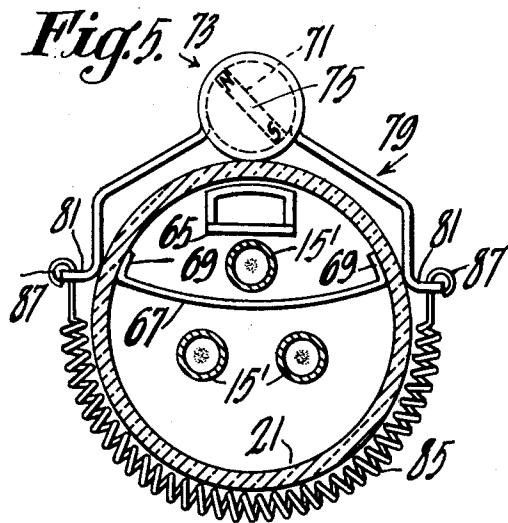
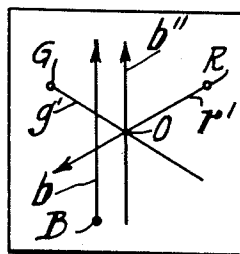


*Fig. 4.*



INVENTORS  
BURTON R. CLAY &  
BY JOHN H. DUBOIS  
William A. Zelenak  
ATTORNEY

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## BEAM CONVERGENCE APPARATUS FOR TRI-COLOR KINESCOPIES

Burton R. Clay, Woodbury, and John H. du Bois, Pennsauken, N. J., assignors to Radio Corporation of America, a corporation of Delaware

Application August 2, 1954, Serial No. 447,338

7 Claims. (Cl. 313—75)

This invention relates to systems for controlling the electron beams of cathode ray tubes and particularly to systems in which a plurality of beams is deflected by a common deflection apparatus.

One type of cathode ray tube with which the present invention may be successfully employed is a color kinescope of the general type having a luminescent screen as part of a target electrode in which different phosphor areas produce differently colored light when excited by electron beam components impinging upon it from different angles, the angle of impingement determining the particular color of the light produced by the phosphor areas.

It is necessary for the satisfactory operation of such kinescopes to effect substantial convergence of the different electron beam components at all points of the raster scanned thereby at the target electrode. In general, this convergence may be effected by means of apparatus such as that disclosed in an article titled "Deflection and Convergence in Color Kinescopes," by A. W. Fried, published in the Proceedings of the I. R. E., vol. 39, No. 10, October 1951, at page 1249. Such beam convergence apparatus includes an electron-optical system by which to control the beam convergence angles. The electron-optical system is variably energized as a function of the radial angle of beam deflection.

Another type of apparatus for controlling the convergence of a plurality of electron beam components and with which the present invention may be employed comprises, in general, means for producing a plurality of electron beam components which traverse predeflection paths that are spaced respectively about the longitudinal axis of the tube and individual electromagnetic means located respectively adjacent to the predeflection beam paths and of such character as to be energizable directly from the beam deflection circuitry in a manner to effect the desired beam convergence. In this manner the beam convergence angle may be varied in a manner suitable to maintain the desired beam convergence in the predetermined plane at all points in the scanned raster. In the type of apparatus which is alluded to, it is also customary to provide a convergence control for the several beam components in the nature of a direct current convergence (i. e. static convergence) in order to effect proper convergence of the several beam components at the center of the screen. That is to say, in addition to the electromagnetic means described above, which are provided for dynamic convergence of the beam components, it has also been found necessary to compensate for misalignment of the electron beam components which results from manufacturing variations and the like. Such compensating means for effecting static convergence may be in the nature of electromagnetic apparatus or permanent magnetic means.

Since the deflection imparted to the several beam components by the "convergence magnets" is a radial one, it has further been found necessary, in order to compensate for manufacturing misalignment of the electron

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guns, to provide means for effecting a controllable tangential deflection of one of the beams whereby to insure precise convergence of the beam components at the target.

It is a primary object of the present invention to provide improved beam convergence controlling apparatus for use with cathode ray tubes such as a tri-color kinescope.

A further object of the invention is to provide an improved magnetic beam convergence controlling arrangement in which a substantial decrease may be effected in the energizing power consumption requirements.

Still another object of the invention is to provide novel and improved beam convergence apparatus for effecting individual control of an electron beam component of a tri-color kinescope in such manner as to permit deflection thereof in a tangential direction.

In general, the present invention is described herein as employed in conjunction with a tri-color kinescope of the type having means for directing a plurality of electron beam components toward a tri-color screen and means including internal magnetic pole pieces for cooperation with individual electromagnets for static and dynamic beam convergence. The invention provides a permanent magnet device associated with one of the electron beam pre-deflection paths for the purpose of providing a permanent magnetic field which serves to afford a controllable static convergence function which is adjustable from a maximum value to zero and reversible and for the purpose of effecting tangential deflection of the beam component. The permanent magnet device may be associated with an internal magnetic pole piece for improved operation in providing the static, tangential convergence control without any undesirable interaction with the static and/or dynamic convergence functions of the so-called "convergence magnets." Moreover, as will be appreciated, the apparatus of the present invention is simple of construction, yet highly stable in use.

As used herein, it will be understood that the term "beam components" denotes either a plurality of individual electron beams emanating respectively from a plurality of electron guns or from a single electron gun provided with suitable apparatus for forming several individual beams.

Additional objects and advantages of the present invention will become apparent to those skilled in the art from a study of the following detailed description of the accompanying drawing, in which:

Fig. 1 is a side-elevation view of a cathode ray tube provided with one form of the invention;

Fig. 1a is a fragmentary, isometric view of a portion of the tube of Fig. 1;

Fig. 2 is a vertical sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a schematic representation of beam convergence apparatus which may be employed in conjunction with the tube of Fig. 1;

Fig. 4 is a graphic illustration of the operation of the invention;

Fig. 5 is a vertical sectional view taken along line 5—5 of Fig. 1;

Fig. 6 is a side-elevation view of a portion of the apparatus of Fig. 5; and

Figs. 7, 8 and 9 are diagrammatic illustrations of the apparatus of Fig. 5 showing different conditions of operation thereof.

Reference first will be made to Fig. 1 for a general description of an illustrative embodiment of an electron beam convergence system in accordance with the present invention. The system includes a tri-color kinescope 11 which may be of the same general type as that disclosed in the copending U. S. patent application of A. M. Mor-

rell, Serial No. 364,041, filed June 25, 1953, now U. S. Patent 2,752,520. It will be understood, however, that the kinescope, alternatively, may be of other types such as that shown in the H. B. Law paper. In either case, however, the kinescope has a luminescent screen 12 provided with a multiplicity of small phosphor areas arranged in groups and capable respectively of producing light of the different primary colors in which the image is to be reproduced when excited by an electron beam. In back of and spaced from the screen 12 there is an apertured masking electrode 13 having an aperture for and in alignment with each group of phosphor areas of the screen 12.

In the particular tube illustrated, the kinescope also has a plurality of electron guns, equal in number to the number of primary colors in which the image is to be reproduced. Each of these guns may be conventional, consisting of a cathode, a control grid and a focussing electrode. Since the three guns are identical, the different parts thereof will be referred to collectively as the cathodes 10, the control grids 14, accelerating electrodes 15 and 15', and the focussing electrodes 16. The three electron guns produce schematically represented beams 17, 18 and 19 by which to energize respectively, the blue, red and green phosphor areas of the screen 12. When these electron beams are properly converged at the masking electrode 13 they pass through the apertures thereof from different directions and impinge upon different phosphor areas of the various groups so as to produce blue, red and green light, as shown in Fig. 1a. It is to be noted that the size of the phosphor areas, the angles between the beams and the spacing of the mask 13 from the screen 12 as compared with the length of the tube are exaggerated for better illustration of the operation of the kinescope.

The electron-optical apparatus of the kinescope 11 also includes a beam-accelerating electrode consisting, in the present instance, of a conductive wall coating 20 formed on the inner surface of the tubular glass neck 21 of the kinescope extending from the region adjacent to the outer end of the focusing electrodes 16 to the conical section 22 of the tube which in this case is metallic. Suitable electrical connection (not shown) is made at the junction of the wall coating with the metal cone 22. Preferably, the target electrode structure, including the masking electrode 13 and the luminescent screen 12, which for this purpose may be metallized, is electrically connected to the metal cone 22 by suitable means. Metallization of a luminescent screen of the character described may be effected in the manner disclosed in a paper by D. W. Epstein and L. Pensak, titled "Improved cathode ray tubes with metal-backed luminescent screens," published in the RCA Review, vol. VII, March 1946, at pages 5-10.

The described electrode structure of the kinescope may be energized in a conventional manner such as that illustrated, by way of example.

The electron beams 17, 18 and 19 are modulated suitably in intensity under the control of color-representative video signals derived from a source 25 whose connection to only the blue gun is illustrated in the drawing. It will be understood that the video signal source is represented herein entirely diagrammatically since it does not form an essential part of the present invention. The signal source 25 usually will be part of a signal receiver and may be understood to include a signal detector, or equivalent device, together with one or more stages of video signal amplification. Alternatively, the video signal source may be a color television camera in the event that the kinescope 11 is employed as a monitor, for example. Also, it will be understood that the illustrated connection of the video signal source 25 to the electron gun of the kinescope 11 is merely diagrammatic and accordingly these connections may or may not be made directly to the control electrode 14. Instead, it will be understood that they may be made to the cathodes

10 or, in accordance with some modes of operation of color image-reproducing apparatus, the video signal source may be connected both to the cathodes and to the control grids of the electron guns.

Also associated with the color kinescope 11 is a deflection yoke 26 which may be entirely conventional including two pairs of suitably placed coils electrically connected together in such a manner that, when properly energized, electromagnetic fields are produced, whereby to effect both horizontal and vertical angular deflections of the electron beams so as to scan the usual rectangular raster. Energization of the deflection coils comprising the yoke 26 may be effected by conventional vertical and horizontal deflection wave generators 27 and 28, respectively. Such apparatus will be understood to function suitably to produce substantially sawtooth energy at both horizontal and vertical deflection frequencies so that the fields produced by the yoke 26 are varied in a substantially sawtooth manner.

The beam convergence system, in accordance with the present invention, also includes a plurality of electromagnetic field producing elements such as the magnets 29 and 30 mounted around the neck 21 of the color kinescope adjacent to the predeflection paths of the electron beam components. It is to be understood that the precise location of these magnets is not necessarily indicated in this figure. Instead, as will appear in greater detail from a subsequent portion of the specification, it is to be understood that each of these magnets is located relative to one of the electron beam components so as to influence its associated beam component to the substantial exclusion of the others. Furthermore, it is to be understood that these magnets are of a character which, when suitably energized, produce respective fields which are transverse to the associated beam paths.

Each of these convergence electromagnets includes a pair of spaced pole pieces and at least one energizing winding. Two windings may be provided for each of the electromagnets for separate energization. These features will be described subsequently in greater detail.

Before describing the details of the convergence system to which the present invention is related, a brief description will be given of the general manner in which the apparatus functions to produce the desired results. The convergence magnets such as 29 and 30 are energized by substantially unidirectional energy so as to effect an initial convergence of the electron beam components, substantially in the plane of the apertured masking electrode 13. In order to do this, the unidirectional energization of these magnets is effected in such a way that the magnets may be individually energized in different magnitudes. In effecting this initial beam convergence, it is to be understood that the beams may be in any desired one of their different deflected positions. For example, they may be initially converged at the center of the raster to be scanned. Alternatively, they may be initially converged at one corner of the raster.

The convergence magnets such as 29 and 30 also are dynamically energized by the control wave energy derived from a suitable generator (not shown in Fig. 1) so as to effect a variation in the magnitude of the transverse fields produced respectively thereby. These field strength variations are in accordance with a predetermined function of the beam deflection. Variations in the strength of the fields produced by the convergence magnets such as 29 and 30 effect corresponding variations in the paths of the electron beam components relative to the longitudinal axis of the tube. Hence, suitable variations are made in the convergence angles between the various beam components so as to produce the desired convergence of the beam components substantially in the plane of the masking electrode 13.

For a further description of this type of beam convergence apparatus, reference now will be made to Fig. 2 of the drawings. This figure shows more clearly the relative positions of the convergence magnets, such

as 29 and 30 and, additionally, 31, relative to one another and to the electron beams with which they are respectively associated. Inasmuch as all of these magnets are substantially the same, only one of them will be described in detail. The convergence magnet 29, which is associated with the blue electron beam 17, is provided with a core having a body portion 32 and two external pole pieces 33 and 34. These pole pieces are mounted so as to be in close association with the tube neck 21. Also, as indicating in Fig. 1, the pole pieces may extend for some distance longitudinally of the tube substantially as indicated. The magnet also is provided with an energizing coil structure 35 mounted upon the body portion 32. The energizing coil 35 may be provided with two windings, one for static energization and the other for dynamic energization in a manner to be described subsequently. The convergence magnet 29 produces a field which, in the vicinity of the electron beam 17, is substantially transverse to the axis of the kinescope. By means of such a field, the electron beam 17 may be moved radially toward or away from the longitudinal tube axis. The direction and magnitude of such a beam movement is controlled by the energization of the magnet by means including the coil 35.

In Fig. 2, it also is illustrated that for each of the magnets there are provided on the inside of the tube neck 21 extended pole pieces so as to increase the effectiveness of these magnets. The magnet 29, for example, is provided with a pair of inwardly extending pole pieces 36 and 37, associated respectively with the external pole pieces 33 and 34. By such means, it is seen that the reluctance of the magnetic circuit is considerably decreased, and also the flux distribution of the field produced between the internal pole pieces 36 and 37 is considerably improved.

Reference now will be made to Fig. 3 of the drawings for a general description of an illustrative manner in which the beam convergence apparatus may be energized. The energizing coils of the convergence magnets 29, 30 and 31 include dynamic windings 43, 44 and 45, respectively. These convergence magnets also include static windings 46, 47 and 48, respectively. The energizing circuit for the static convergence windings 43, 44 and 45 includes a series circuit of resistors 49, 50 and 51 connected between the positive terminal of a power supply and its load. These resistors are illustrated as adjustable to enable the individual control of the energizing current for the associated static windings of the convergence magnets 29, 30 and 31, respectively.

The dynamic windings 43, 44 and 45 of the convergence magnets 29, 30 and 31, respectively, are connected in series with one another and to vertical and horizontal convergence wave generators 52 and 53, respectively. These convergence wave generators may be of the general type disclosed in the I. R. E. Friend paper or any other suitable form. In general, the substantially sawtooth wave energy 54 of field frequency which is derived from a conventional vertical deflection wave generator 27 for energization of the vertical deflection coils 55 is converted by means of the vertical convergence wave generator 52 into a substantially parabolic wave 56. This parabolic wave energy is coupled by a capacitor 57 to the series connection of the dynamic windings of the convergence electromagnets. In a substantially similar manner, the line frequency sawtooth wave energy 58 derived from the horizontal deflection wave generator 28 for the energization of the horizontal deflection yoke windings 59 is converted by the horizontal convergence wave generator 53 to substantially parabolic wave 60 for impression by means including a coupling capacitor 61 upon the dynamic windings of the beam convergence electromagnets 29, 30 and 31. By such means, it is seen that all of the convergence magnets are similarly energized dynamically as functions of both vertical and horizontal beam deflection angles so as to effect substantial convergence

of the electron beam components at the target electrode structure at all points in the scanned raster.

Insofar as static convergence of the several electron beams 17, 18 and 19 at the target electrode is concerned, direct currents of the proper magnets applied to the several windings 46, 47 and 48 will cause transverse magnetic fields between the internal pole pieces (Fig. 2) for effecting radial movement of the several beams toward the tube axis. Such operation is illustrated in Fig. 4 wherein the spots produced by the beams at the target are indicated by the dots designated "R," "G" and "B," the direction of static deflection of the beam spots being indicated by the several arrows "g" and "b." Regardless of whether the kinescope is of the type in which the several guns are parallel to each other or of the type in which the guns are tilted slightly toward the axis of the tube, manufacturing tolerances may result in a misalignment of the guns such that the beam spots "R," "G" and "B" cannot be converged to a common point. That is to say, the illustration of Fig. 4 is representative of a situation in which the red and green spots, by virtue of their radial deflection by the convergence magnets 39 and 40 have been caused to coincide at a common point "O." The blue spot, however, as a result of misalignment of its gun cannot be brought into coincidence with the red and green spots at the point "O." Hence it is necessary to introduce a correction into the deflection of one of the beams by a magnetic field which causes substantially tangential deflection of the beam. Thus, if the additional correction be introduced in the predeflection path of the blue beam, tangential movement thereof will cause the blue beam to be moved to the location of the arrow "b" which, as will be noted, intersects the other two beams at the point "O."

Lateral or tangential corrective deflection of one of the beams (e. g. the blue beam 17) is accomplished through the agency of the following apparatus, as shown, in Fig. 5, the tube neck 21 of the kinescope 11 includes a pair of internal pole pieces 65 and 67 which are mounted, by way of illustration, above and below the second focusing electrode 14' of the blue electron gun. The pole pieces 65 and 67 may, as shown, be fixed to the tubular electrode 14' and generally at right angles to the internal pole pieces 36 and 37 which are associated with the beam convergence electromagnet 29. Thus a magnetic field between the pole pieces 65 and 67 will introduce a beam deflection perpendicular to that which results from the radial deflection in the region of the pole pieces 36 and 37. The pole piece 65 may, if desired, be of a box-like construction, that wall of the box adjacent the neck 21 of the kinescope being arcuate in order to follow the curvature of the neck. The pole piece 67 extends across the interior of the kinescope neck 21 and may have upwardly extending flanges 69 for the purpose of affording a larger area to the flux which is passed through the pole piece 67 by the apparatus mounted externally of the tube neck. Permanent magnetic field lines are caused to traverse the region between the two pole pieces 67 and 65 by means of a permanent magnet 71 which is supported outside of the neck of the kinescope but in the region of the blue gun. The permanent magnet 71 may, in accordance with a specific form of the invention, comprise a bar magnet having north and south poles at its opposite extremities. The magnet 71 is illustrated as being carried by a bobbin or spool 73 which is rotatable about an axis 75 coinciding with the center of the magnet 71. The structure of the bobbin 73 and magnet 71 is best seen from the side elevational view of Fig. 6 which is partially in section for the purpose of revealing the bar magnet. Each end of the bobbin 73 which may be formed, for example, of any suitable non-magnetic material such as polystyrene or the like is or may be provided with a continuous flange 77, such that the main portion of the cylindrical bobbin 73 is recessed with respect to the ends thereof. The bobbin 73 is supported for rotation about

the axis 75 by means of a generally U-shaped strap 79 whose lower ends 81 are offset in the same direction from the center portion thereof and are positioned adjacent the flanges 69 of the internal pole piece 67. The central portion of the bight of the U-shaped strap 79 is provided with a generally semi-cylindrical saddle portion 83, which saddle portion subtends an angle of at least 180° for purposes which will become apparent hereinafter.

The strap 79 is resiliently urged into the position shown in Fig. 5 against the neck of the kinescope by means of a coil spring 85 whose ends are provided with hooks 87 for engagement with apertures (not shown) in the ends 81 of the strap. The spring 85 should be of a non-magnetic material such as Phosphor bronze or the like. Since the particular materials of which the various components of the apparatus of Fig. 5 are formed do not constitute a part of the present invention, it is sufficient to note that the strap 79 must have the properties of being flux permeable and of having low retentivity. One suitable material for the strap 79 is a nickel-iron alloy or even a soft iron such as Armco iron. Each of the pole pieces 65 and 67 should similarly be permeable and of low retentivity, so that either of the above-named materials is suitable therefor.

In the operation of the present invention as illustrated in Fig. 5, rotation of the bobbin 73 about its axis 75 will produce a magnetic field transversely of the path of the blue beam, the strength and direction of which field are determined by the angular position of the bar magnet 71 which may be rotated by grasping the flange 77 of the bobbin and turning it. Rotation of the bobbin is, as will be understood, aided by the bearing surfaces provided by the strap saddle portion 83 and the glass neck of the kinescope. Specific examples of the expression of the invention are shown in Figs. 7, 8 and 9 wherein the transverse magnetic fields for producing different types of lateral deflection of the blue electron beam 17 are shown. In Fig. 7, therefore, wherein the bar magnet is oriented so that it is substantially vertical and with its north pole adjacent the saddle 83, a magnetic field of maximum strength is produced by virtue of the flux paths provided by the two ends of the U-shaped strap 79 and the internal pole pieces 67 and 65. The illustrated position of the magnet will, therefore, produce lateral or tangential deflection (i. e. along a horizontal line as viewed in the drawing) of the blue electron beam 17 in a given direction, namely, to the left. In Fig. 8, the magnet 71 has been rotated 45° from its position in Fig. 7. The field between the pole pieces 67 and 65 will, therefore, be in such direction as again to produce tangential deflection of the beam 17 to the left but in an amount proportional to the cosine of the angle by which the magnet is displaced from the vertical. From the foregoing, those skilled in the art will appreciate the fact that where the magnet 71 is oriented in the reverse manner from that shown in Fig. 7, namely, such that its south pole is uppermost, a maximum strength transverse field will be produced between the pole pieces 65 and 67 but of the opposite direction. That is, deflection of the beam 17 would then be to the right as viewed in the drawing.

One real advantage of the present invention is that it affords the reversibility of the magnetic field produced, such reversibility being effected by rotation of the magnet 71 about its axis. Another important advantage of the present invention is that it produces a field which is reducible to substantially zero strength, such attribute being of importance where, for example, it is desired to eliminate completely a lateral deflection of the beam. This last-recited capability of the invention which is, moreover, difficult of realization with prior art structures, is made possible by reason of the relationship of the arcuate saddle 83 with respect to the bar magnet 71 and is illustrated in Fig. 9. Since, as has been set forth, the arcuate saddle 83 subtends an angle of at least 180°, it necessarily follows that for at least one angular position

of the magnet 71, both its north and south poles will lie within the arc encompassed by the saddle, so that the saddle 83 provides a substantial short circuit for flux lines between the north and south poles of the magnet. When the magnet is, therefore, oriented as shown in Fig. 9, its flux lines are confined to the saddle 83 and cannot produce a field between the pole pieces 67 and 65.

From the foregoing, it will be noted that, in addition to the facts that the apparatus of the present invention affords a wide range of adjustability of the magnetic field between a maximum and zero, as well as reversibility of the field direction and that the apparatus of the invention is possessed of both mechanical and magnetic stability, despite its simplicity of structure, possesses the further important advantage that there is substantially no possibility of "spill-over" of the magnetic field from the permanent magnet 71. That is to say, the magnetic field lines produced herein are confined to the magnetic paths provided by the strap and internal pole pieces and cannot interfere with the electron beam upon which it is operating in a deleterious manner or upon the other beams in the tube. Such spill-over has been found to be difficult of elimination in prior art structures wherein reduction of field strength can be accomplished only by movement of the magnet in a direction perpendicular to but away from the longitudinal axis of the kinescope, since even such movement gives rise to undesirable fields within the kinescope neck.

Thus it should be apparent that the present invention provides permanent magnetic apparatus for accomplishing in a less expensive structure the results of more complex electromagnet arrangements and with certain advantages not heretofore realized with other permanent magnet devices.

While the invention has been described in accordance with a specific embodiment employing a bar magnet supported for rotation about an axis passing normally through its physical center, it should be borne in mind that other physical structures may be employed, such, for example, as a cylindrical magnet which is magnetized along a diameter. In the latter case, the cylindrical magnet would obviate the need of the plastic bobbin but the supporting strap would still require a saddle which encompasses at least 180°.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. An electron discharge device comprising an envelope having a tubular portion; an electron gun mounted within said tubular envelope portion for forming an electron beam; and means for producing a magnetic field transversely of the path of such beam, said last-named means including a permanent magnet having north and south poles and a central axis located between said poles and a continuous U-shaped strap of a magnetic material, the bight of said U-shaped strap having an arcuate portion supporting said magnet therewithin with said central axis coincident with the axis of said arcuate portion whereby with rotation about said axis said north and south poles are adapted to travel in a circular path concentric with and within said arcuate portion, said arcuate portion encompassing an arc of said path of at least 180° to provide a substantially short circuit for said magnet in a selected rotational position thereof.

2. An electron discharge device comprising an envelope having a tubular portion; an electron gun mounted within said tubular envelope portion for forming an electron beam; and means for producing a magnetic field transversely of the path of such beam, said last-named means including a permanent magnet having north and south poles and a central axis located between said poles and a continuous U-shaped strap of magnetic material, the bight of said U-shaped strap having an arcuate portion supporting said magnet between said strap and said tubular envelope portion with said central axis coincident with the axis of said arcuate portion whereby with rotation

about said axis said north and south poles are adapted to travel in a circular path concentric with and within said arcuate portion, said arcuate portion encompassing an arc of said path of at least 180° to provide a substantially short circuit for said magnet in a selected rotational position thereof.

3. An electron beam deflecting means for mounting on an envelope portion of a cathode ray tube, said deflecting means comprising a single continuous permeable magnetic strap having a portion thereof shaped substantially in the shape of a U, the central portion of said U-shaped strap having an arcuate configuration, a permanent magnet within said arcuate strap portion, means rotatably supporting said magnet within said arcuate strap portion with the poles of said magnet adjacent to said strap and moveable in a circular path concentric with said arcuate portion.

4. The invention of claim 3 wherein said magnet support means includes a non-magnetic permeable bobbin supported by said arcuate strap portion.

5. The invention of claim 3 wherein said arcuate strap portion encompasses an arc of said path of at least 180°.

6. An electron beam deflecting means for use with a cathode ray tube having an envelope and means within said envelope for forming an electron beam, said deflecting means comprising a single continuous arcuate permeable metal strap adapted to extend around a portion of said envelope with the ends of said strap terminating on opposite sides of said electron beam path, a permanent

magnet, means mounting said magnet for rotation about an axis between the poles of said magnet and within the bight of said arcuate strap whereby said magnet will be positioned between said strap and said tube envelope when in operative position.

7. An electron beam deflecting means for use with a cathode ray tube having an envelope and means within said envelope for forming an electron beam, said deflecting means comprising a single continuous permeable metal strap having both ends thereof offset in the same direction from the central portion of said strap whereby said strap may be positioned around a portion of said envelope with said ends thereof terminating on opposite sides of said electron beam, a permanent magnet, means including the central portion of said strap rotatably mounting said magnet within said central strap portion on the side of said strap from which said strap ends are offset whereby said strap provides a substantial short circuit for the flux of said magnet in at least one rotational position of said magnet.

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